(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 May 2001 (25.05.2001)

PCT

(10) International Publication Number
WO 01/37062 A1

(51) International Patent Classification[7]: G05D 23/19, F25D 29/00

(21) International Application Number: PCT/GB00/04358

(22) International Filing Date:
16 November 2000 (16.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9926952.4 16 November 1999 (16.11.1999) GB

(71) Applicant *(for all designated States except US)*: UNIVERSAL MASTER PRODUCTS LIMITED [GB/GB]; 23 Station Approach, Hayes, Bromley, Kent BR2 7EQ (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: LAMSTAES, Andre [GB/GB]; Universal Master Products Limited, 23 Station Approach, Hayes, Bromley, Kent BR2 7EQ (GB). LAMSTAES, Guy [GB/GB]; Universal Master Products Limited, 23 Station Approach, Hayes, Bromley, Kent BR2 7EQ (GB). BANHAM, Harry [GB/GB]; Universal Master Products Limited, 23 Station Approach, Hayes, Bromley, Kent BR2 7EQ (GB).

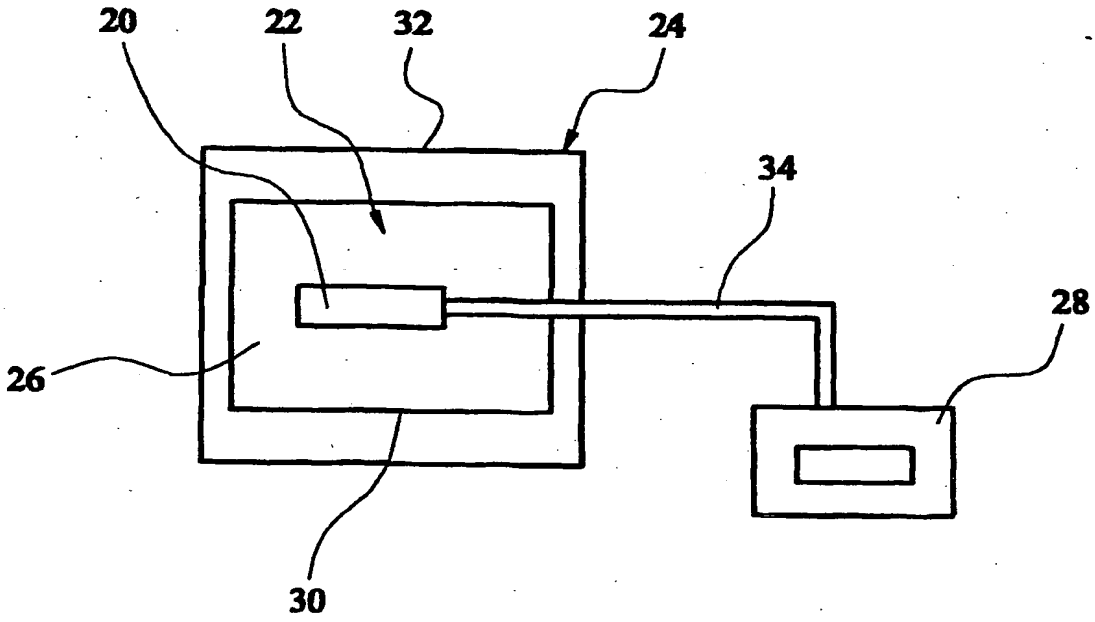
(74) Agent: ARCHER, Philip, B.; Urquhart-Dykes & Lord, New Priestgate House, 57 Priestgate, Peterborough, Cambs PE1 1JX (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR CONTROLLING REFRIGERATION



(57) Abstract: A thermal sensor (20) located in the centre of a food simulant composition (24) linked to a remote measuring indicating and/or regulating device (28). The temperature of the food simulant changes in the same way as food stored in its vicinity and is unaffected by the movement of the ambient air which varies in temperature dramatically. This allows an actual reading and recording of stored food temperature and the regulation of the temperature within a refrigerated space by a thermostat (16). Its uses are mainly for frozen, chilled and refrigerated food, and the reading of temperature of food cooked for example in micro-wave ovens.

WO 01/37062 A1

METHOD AND APPARATUS FOR CONTROLLING REFRIGERATION

This invention relates to a method and apparatus for controlling refrigeration apparatus. An example of the application of the invention is to a method and apparatus for controlling the operation of domestic and commercial food storage refrigeration apparatus including deep freeze apparatus. However, the invention also provides, as such, the apparatus which operates in accordance with the aforesaid method for controlling such refrigeration apparatus, and provides temperature sensing apparatus.

Further aspects of the invention relate to the use of the method and apparatus for the control of apparatus for raising the temperature of food and the like, for example microwave cooking apparatus. Further aspects of the invention relate to a method and apparatus for conducting thermal tests and calibration in relation to refrigeration and heating apparatus.

There is disclosed in WO 94/10546 (reference P51957WO) a method and apparatus applicable to temperature sensing in relation to refrigeration equipment in which provision is made for a means to enable visual inspection of temperature sensing apparatus (for example a conventional bulb and meniscus column-type thermometer) which has been stored in a refrigerator and then removed for inspection, without the attendant inaccuracy of temperature measurement arising from immediate response of the thermometer to the raised air temperature outside the refrigerator or, if such inspection is effected without removal from the refrigerator, the effect of the ingress of external warm air into the refrigerator.

For this purpose, the apparatus of the WO 546 specification provides for the thermometer to be entirely encased within a transparent capsule containing ethylene

sensing of such temperatures is by internal sensing within a simulated body of food. Thus, in accordance with this approach, the method and apparatus of the invention provides the means whereby temperature can effectively be sensed from within food stored within the refrigerator, or in the case of a heating system (such as a microwave oven) from within food being heated in such a heating appliance.

By adopting an approach in which, instead of seeking to damp out the effect of incoming warm air and providing instead the means to sense temperature from within the food itself, yet without the hygiene and related problems of invasive probes, there is provided a method and apparatus which has the capability of providing the user with that which he or she actually wants namely the temperature of the food in question.

This latter factor is of great relevance, we have discovered, since although (as the prior art teaches) the air temperature within a refrigerator or deep freeze rises rapidly when the door is opened, the actual effect of the air temperature on the stored food is often quite marginal and there can be a temperature difference between the air and the stored food of 10°C or more while an unmodified air temperature sensing system in a refrigerator (as is conventionally provided in domestic appliances) will react relatively wildly to such fluctuations, and such is obviously undesirable for energy conservation reasons. Equally there is the converse situation where the approach has been taken that such over-reaction of the temperature control system is ineffective and wasteful, but it is equally true that mere damping of the system is not the effective answer either because damping merely lowers the amplitude of the reactive peaks of the system without addressing the underlying problem or question.

The method and apparatus of the embodiments of the present invention does address that underlying question and

characteristics required to be sensed. In this manner the embodiments enable the apparatus and method to provide a signal which can be used either for controlling refrigeration apparatus or for indicating food temperature, or indeed both, so as accurately to reflect the thermal behaviour of an item of foodstuff place alongside the temperature-sensing and food-simulating article. Actual examples of the materials to be employed are described below. These materials are usually in gel or wax-like format and thus require suitable encasement for practical handling in the refrigeration and/or heating appliance environment. Accordingly, the food simulant material is provided with a casing which typically may comprise a plastic moulding corresponding in size to a typical food article for refrigerational storage in the envisaged use environment, and which may additionally be provided with one or more further layers of material to simulate the thermal effects of packaging which is conventionally employed in relation to articles stored in refrigerators or deep freezers. This latter aspect of the thermal characteristics of the simulated article of food may be incorporated into the overall thermal package without the need for providing specific physical counterparts of the packaging as such. For example, the effect of such packaging might be reasonably closely approximated to by adopting a somewhat larger size for the overall simulated food article. However, such an approach is not strictly in accordance with the principles of some of the embodiments of the present invention, for which the approach is to adopt, for temperature sensing purposes, a simulated food article of a size corresponding to a typical stored food article and having within it not only simulated food with the temperature sensing device therein, but also simulated packaging to correspond with the conventional packaging, but not of course overlooking the requirement for durability in terms of the intended use of

hard wiring loose connectors. One option might be to provide a series of food-simulating articles plugged into the cabinet of the apparatus at suitable locations and from which the signals would be monitored and evaluated on an overall assessment basis.

Another aspect of the invention relates to the use of the food-simulating article and the contained thermal sensor therein in relation to a method for controlling the operation of refrigeration or deep freeze apparatus so as to achieve significant energy savings in relation to power consumption for driving the pump of conventional refrigeration apparatus. In accordance with this aspect of the invention the control method and apparatus are adapted to provide a degree of control of the refrigerant pump (or other driveable thermal transfer apparatus) such that the extent of operation of the pump matches to a close approximation that which is actually required to produce the desired level of refrigeration of the food, avoiding the peaks and troughs associated with conventional control systems which sense air temperature only and the corresponding thermally damped peaks and troughs of the prior art apparatus discussed above. Thus, these embodiments of the invention provide improved refrigeration unit response pattern (in terms of pump drive periods and/or formal heat transfer quantum per unit time). This result is achieved by providing in accordance with the principles of the invention a refrigerant drive system control signal which is generated on the basis of a food-originating temperature-dependent control signal. This has the result that the power consumption of the refrigerant system matches the actual requirements of the apparatus and its enclosing cabinet instead of being related to relatively irrelevant factors such as the air temperature in the cabinet and/or a perceived requirement to damp the responsiveness of the control system. In this manner there are achieved

FOOD SIMULANT TEMPERATURE MEASURING DEVICE

This invention is a thermometric device to shadow the temperature of food stored within its vicinity by sensing the temperature of a food simulant which is itself a food product encapsulated in a recipient, without being affected by the changes of the ambient temperature. The invention is a generic product covering different applications involving storage of food and other commodities which must be kept within a specific temperature range.

The invention relates to the method and apparatus applicable 1) to the remote sensing of a food simulant to indicate the temperature of food stored in cold rooms, refrigerated or heated containers and other storage spaces for reading, recordal or other purposes, 2) to regulate through the medium of a thermostat of the temperature of cold rooms, refrigerated or heated containers or other storage areas, 3) to indicate the temperature of food cooked in ovens particularly micro wave ovens.

The invention will ensure that the products stored or cooked are at or within the degrees of temperature suggested or imposed by Health Authorities or other regulated bodies.

APPLICATION FOR COLD TEMPERATURE

1) We shall first describe the application for all foods and perishables stored at low temperatures which require a refrigerated element for processing, storage, manufacture transport and the like.

2) The invention is for use in any refrigeration system

John Barr butchers E-coli case (heard in a U.K Court).

5) The present invention consists of an inner recipient which contains food simulant that has the consistency of average food; this inner recipient consequently represents an average food. In its centre is a temperature sensor device. This inner recipient is enclosed in an outer perforated hard plastic case designed to give an accurate temperature reading of food within an average commercial packaging. The sensor being located at the centre of the device being 16 to 18mm from its closest surface becomes in effect a thermal probe within its own food. This allows accurate temperature monitoring of food located in the vicinity of the invention, or of the refrigeration running controls as later described. The invention indicates at all times the temperature at 16mm to 18mm inside the food simulant and as a corollary within the food stored in its vicinity without damaging said food or risking the real possibility of cross contamination.

6) The invention can be fitted with audible or visual warnings for example when the temperature of the food simulant exceeds its safety limit. The warning could be located either inside a refrigerator or on the outside. Such a device from a temperature recording device stimulated by air would be to all intents and purposes ineffectual because of the constant fluctuations of the air temperature which would trigger each time the warning alarm and cause confusion and irritation to people within hearing distance.

7) A prior proposal in this technical field is to be found in GB 2286884 originating from the present applicant which discloses a system in which a bulb or stem type thermometer is mounted within a transparent container and immersed in a transparent liquid or gel having relatively high terminal

11) The user may need to check the temperature of refrigerated or frozen foods stored in different zones within a refrigerated space to establish temperature variants so that vulnerable products can be stored in more favourable positions for example in a multi-deck self service display refrigerated cabinet where the difference in temperature from base to top can vary quite considerably; inside an average size refrigerated container the difference in temperature can often be 8deg C/14def F if not more. The small size of the recipients of the invention will enable the user to place them in different zones of the refrigerated space in order to monitor their temperature: as explained in paragraph 10 this can be done at regular intervals or with a permanent connection.

12) Where multiple refrigeration systems are in operation, devices of this kind may be provided in as many locations as required, with the thermal output data routed in a monitoring system permitting monitoring and recordal of temperature data for each location on a time-related basis, whereby a visual display, digital recordal or print out can be obtained indicating temperature levels of food or other refrigerated product in the said locations over a given period of time, regardless of air movement. General temperature fluctuations particularly where there are perishable goods can also be monitored and recorded and any abnormal movements in any particular area immediately signalled.

13) In transportation of goods loaded in refrigerated transport container, their temperature cannot usually be monitored accurately which may lead to disputes between shippers and buyers. The invention will supply the necessary data and confirm the movement of temperature during the voyage including period of transit. Temperature

17) An embodiment of the invention detailed in paragraph 5) above will now be described by way of example with reference to the accompanying drawings in which figure 1 shows an outer container 3 representing the skin, surface or wrapping of food encapsulating an inner container 4 filled with a composition 5 simulating food, in which is inserted the sensor 6 linked to a read-out 1 indicating the temperature of said substance by a connecting cable 2. The sensor is inserted at about 17mm within the inner container.

APPLICATION FOR HOT TEMPERATURE

18) Food Hygiene Regulations in the EC stipulate that hot food must be kept at a certain minimum temperature. It is usually 63degC/46degF or higher. In some areas like Scotland food that is re-heated must reach 82degC. Probes are usually the only temperature measuring device available.

19) The present invention offers a device which monitors the temperature of the hot food either as a permanent fixture or temporary to be used as and when required. For this application the materials required are different from the ones used in the previous chapter requiring cold temperature but otherwise the principle remains the same.

APPLICATION FOR THERMOSTAT

20) The thermostat regulates the temperature inside the refrigerated space. When the temperature exceed a pre-set level it activates the refrigeration cycle; the mechanism is switched on automatically by the increase of air temperature usually at the air-in. As explained air temperature varies constantly with door openings and other activities associated with refrigeration storage already mentioned

temperature of -18 degC/0 degF consequently when food is frozen at a lower temperature, the defrost facility will cease to operate before the food is completely defrosted. The cooling period will therefore start with food still partly frozen which will be insufficiently cooked at the end of the cooking period. The error is caused because it is usually assumed that freezers maintain the food at the right temperature and that the thermostat read-out is a thermometer readout; the temperature of the food itself is not checked with a reliable food thermometer and the result is a health hazard.

24) In a microwave oven, food is cooked from within and the air temperature is not affected. Consequently the only method to check the food temperature is to use a probe. We have already pointed out the high risks of using probes in food for consumption.

25) The invention consists of a pack of food simulant for food of a particular weight, density and composition, supplied with a temperature sensor to read the temperature of the pack before and after being cooked and comparative tables if required. The object is to test the efficiency of the micro-wave oven.

26) Initially in a chilled state, the invention is designed to be "cooked" in the micro-wave oven to reach a specific temperature over a set period of time. When the time is over, the temperature of the pack is taken with the sensor. If the temperature of the pack reaches the said specific temperature, the oven cooks satisfactorily. If it does not, the cooking time must be adjusted on the comparative charts supplied with the invention which will then be used to indicate the period of cooking for particular types of food.

1) A temperature measuring or indicating device comprising a thermal sensing device mounted in a thermal inertia housing in which the sensing device remains in intimate contact with a composition simulating food sealing in the housing.

2) A device according to claim 1 wherein the housing is encapsulated in an outer protective receptacle.

3) A device according to claim 2 in which the thermal probe or heat sink is set in the centre of the inner housing isolated from the fluctuations of the temperature of the ambient atmosphere reacting solely to the thermal state of the said composition.

4) A device according to claim 3 in which the thermal probe gives a visual display of the temperature for reading and/or recordal.

5) A device according to claim 3 linked by a data transmission conduit to a temperature measuring display unit or computerised system for reading and/or recording purposes by means of a data transmission conduit the device being either permanently connected or passing through a connector.

6) A device according to claim 3 in which the heat sink or thermal probe generates electronic digital signals relating to changes of the temperature of the simulated food composition to an automatic temperature regulator by means of a direct data transmission conduit to cause the regulator to react soley with the change of temperature of the composition and not with the change of temperature of unrelated media such as ambient air.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which Fig 1 shows a diagrammatic representation of apparatus for controlling article heat transfer apparatus in accordance with the invention;

Figs 2 and 3 show plan and perspective and sectional views through an embodiment of temperature sensing apparatus employing a thermal sensor within a body of food simulant material;

Fig 4 shows a further embodiment of the thermal sensor of Figs 2 and 3;

and figs 5 and 6 show graphic representations of the operation of prior art apparatus (Fig 5) and apparatus according to an invention (Fig 6) illustrating the reduced number of operating cycles within a given period produced by the apparatus of the invention.

As shown in Fig 1 apparatus 10 for controlling article heat transfer apparatus 12 connectable to an energy source 14 comprises control apparatus 16 to control the operation of the heat transfer apparatus 12 in accordance with sensed thermal characteristics.

A chamber 18 is provided to contain one or more of the articles (not shown) to or from which heat transfer is to be effected, during operation of the heat transfer apparatus.

Chamber 18 is in operative association with the heat transfer apparatus 12 so that the latter can cause heat transfer to or from the chamber and hence to or from articles contained therein.

Control apparatus 16 comprises a thermal sensor 20 responsive to sensed thermal characteristics within the chamber.

Control apparatus 16 further comprises a thermal sink

Wax Refining Co Limited of Redhill. For example, cheese wax 2110 grade for dipping/coating cheeses. The wax is a blend comprising a mixture of hydrocarbon waxes and food grade white oil.

Other food grade material may be suitable for the purpose on the basis of the characteristics discussed above and apparent from the two examples disclosed above.

Turning now to the embodiments shown in Fig 2, 3 and 4, these show the thermal sensor 20 of Fig 1 used instead in association with a digital readout 28. Sensor 20 is located within the body of food-simulant material 26 which is contained by a cylindrical capsule 30 positioned within a rectangular body 32 of simulated packaging material. A bracket 34 mounts readout 28 on the packaging 32 and capsule 30 and serves as a conduit for hardwiring conductors not shown.

In the embodiment of Fig 4, there is additionally provided a clip or mounting 36 for screwing or adhering to the refrigeration cabinet.

Capsule 30 and simulated packaging 32 and (34) and clip or mounting 36 may all comprise suitable plastics materials moulded or otherwise.

The diagrams of Figs 5 and 6 illustrate the mode of operation of the apparatus of Fig, Fig 6 showing that over a six hour period such apparatus made only 10 starts in terms of commencing operation of the heat transfer apparatus whereas the corresponding conventional equipment shown in Fig 5 made 30 such starts during a similar period illustrating the significant reduction in use and wear and tear on and energy consumption by the refrigeration apparatus.

The plots of Figs 5 and 6 are of temperature against time as sensed from a thermal probe located in condenser equipment of the heat transfer apparatus.

temperatures.

2. A method of controlling article heat transfer apparatus comprising providing a thermal sensor responsive to sensed thermal characteristics within a chamber and providing a thermal sink or body associated with the thermal sensor and comprising a body of food simulant material having said thermal sensor located therein and adapted to provide a food-originating temperature-dependent control signal to heat transfer apparatus based upon the temperature within the food simulant.

3. A method according to claim 1 or claim 2 characterised by providing said heat transfer apparatus comprising refrigeration apparatus.

4. A method according to claim 1 or claim 2 characterised by providing said heat transfer apparatus comprising cooking apparatus.

5. Article heat transfer apparatus comprising:

a) drivable heat transfer apparatus connectable to an energy source;

b) control apparatus for said heat transfer apparatus to control the operation thereof in accordance with sensed thermal characteristics;

c) a chamber to contain one or more of said articles during operation of said heat transfer apparatus;

d) said chamber being in operative association with said heat transfer apparatus and adapted to cause the latter to effect heat transfer to or from said chamber;

e) said control apparatus comprising a thermal sensor responsive to sensed thermal characteristics within said chamber;

f) said control apparatus further comprising a thermal sink or body associated with said thermal sensor and having a thermal capacity adapted to modify the responsiveness of said control apparatus to the thermal

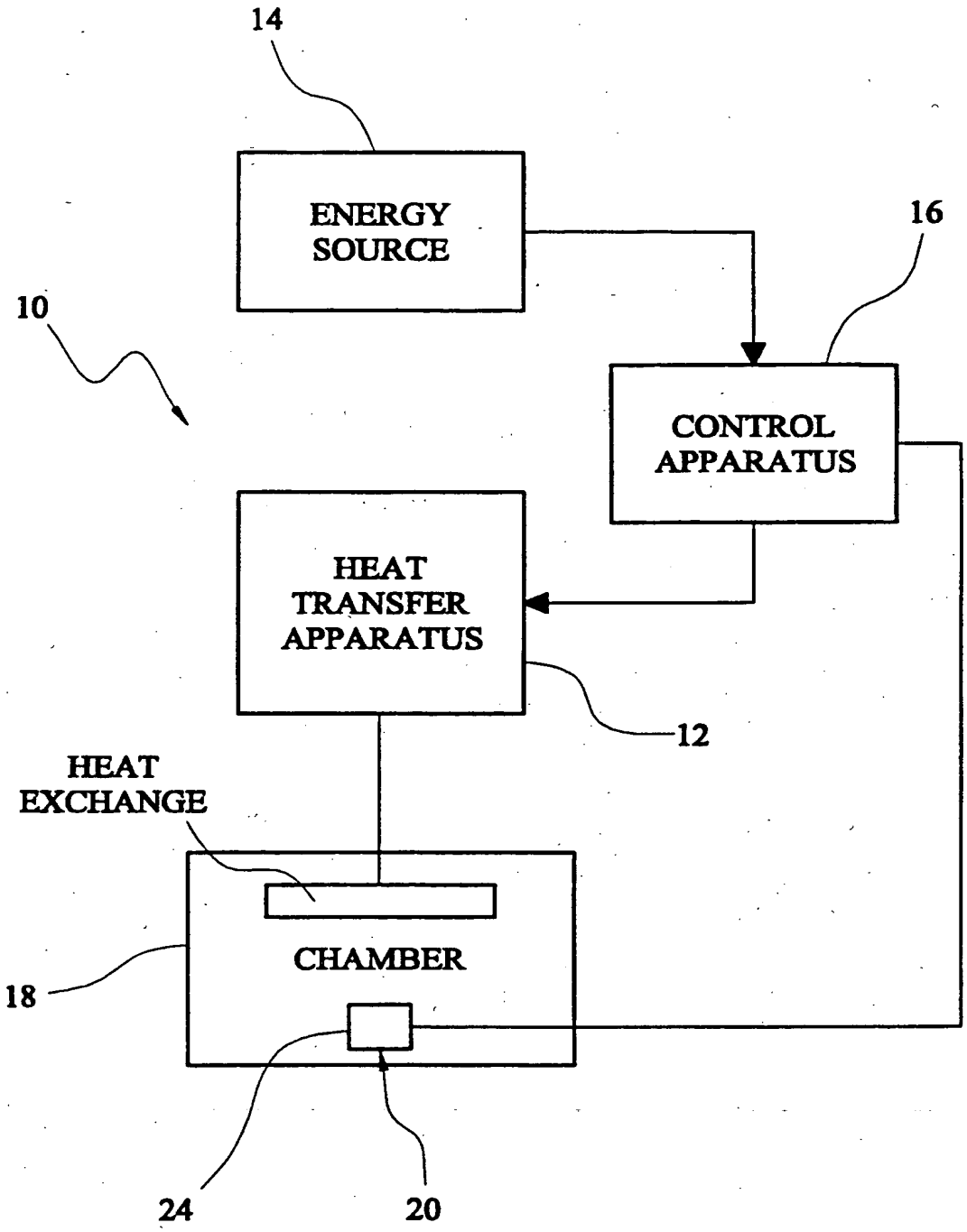


FIG. 1

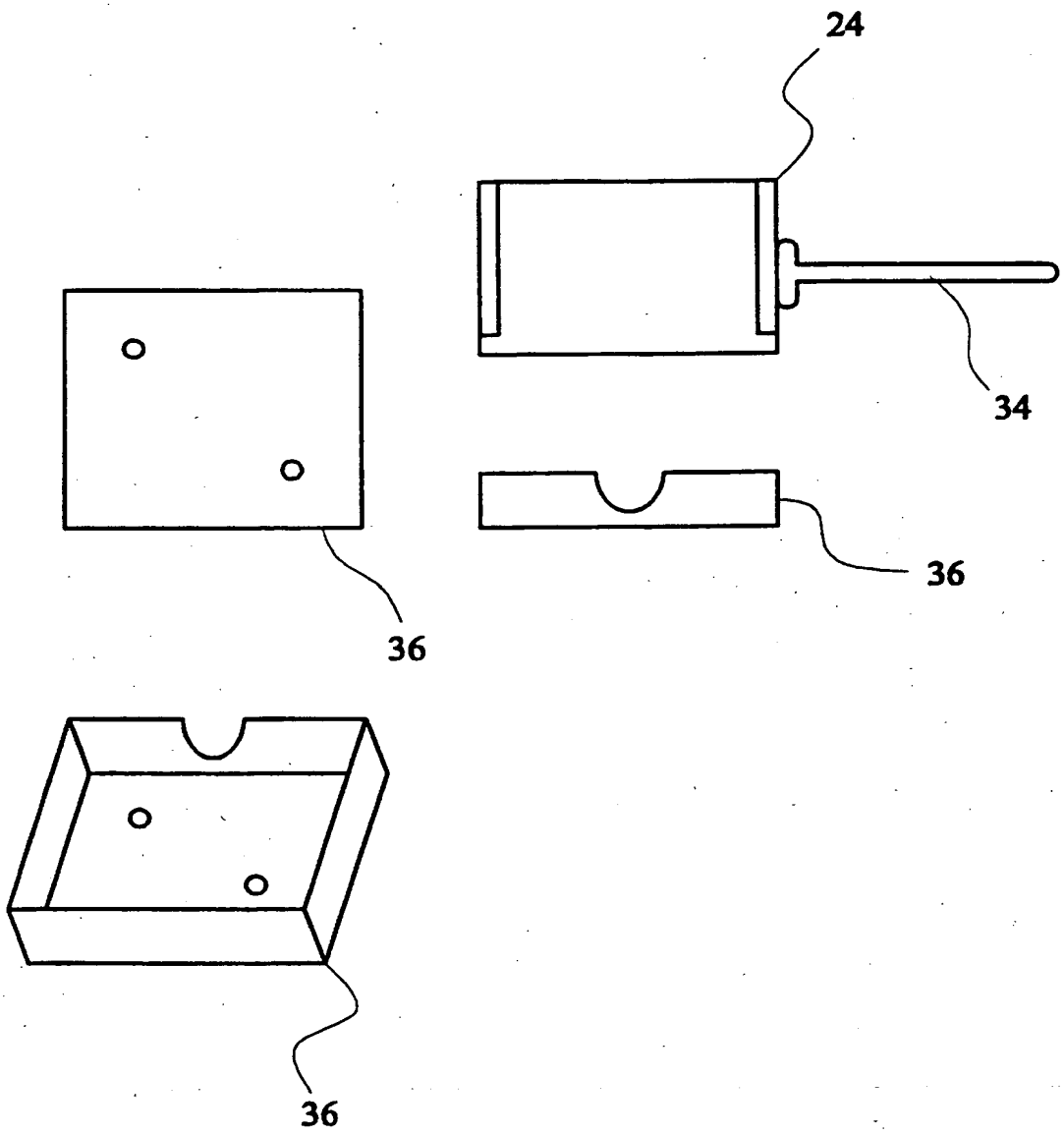


FIG. 4

INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/GB 00/04358

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D23/19 F25D29/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05D F25D G01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 928 935 A (SANYO ELECTRIC CO) 14 July 1999 (1999-07-14)	2,3,6,7, 9
Y	the whole document	4,8
A		1,5
Y	US 4 626 662 A (WOOLF STEPHEN R) 2 December 1986 (1986-12-02)	4,8
A	claim 1; figure 2	1-3,5-7
X	WO 94 10546 A (BANHAM HARRY FRANCIS) 11 May 1994 (1994-05-11) cited in the application	9
A	the whole document	1-8
X	US 2 923 786 A (JONES DONALD R.) 2 February 1960 (1960-02-02)	9
A	column 1, line 49 - line 62; figure 1	1-8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 February 2001	06/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Philippot, B

1

Form PCT/ISA/210 (second sheet) (July 1992)